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NATIONAL DAM SAFETY PROGRAM. WARRENSBURG COUNTRY CLUB LAKE DAM --ETC(U)
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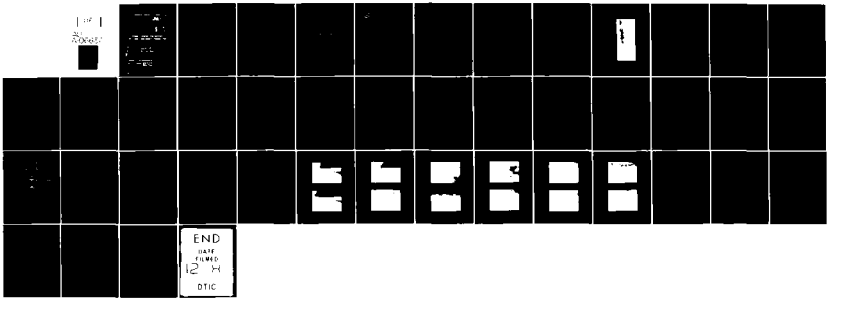

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MISSOURI-KANSAS CITY BASIN

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LEVEL II

WARRENSBURG COUNTRY CLUB LAKE DAM

JOHNSON COUNTY, MISSOURI

MO 20248

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

United States Army
Corps of Engineers
Serving the Army
Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1979

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
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National Dam Safety Program. Warrensburg Country Club Lake Dam (MO 20248), Missouri - Kansas City Basin, Johnson County, Missouri. Phase I Inspection report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MISSOURI-KANSAS CITY BASIN

WARRENSBURG COUNTRY CLUB LAKE DAM

JOHNSON COUNTY, MISSOURI

MO 20248

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Warrensburg Country Club Lake Dam Mo. ID No. 20248
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Warrensburg Country Club Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division — Date: 16 APR 1980

APPROVED BY: SIGNED
Colonel, CE, District Engineer — Date: 16 APR 1980

WARRENSBURG COUNTRY CLUB LAKE DAM

JOHNSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20248

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Warrensburg Country Club Lake Dam
State Located	Missouri
County Located	Johnson County
Stream	Tributary to Post Oak Creek
Date of Inspection	23 August 1979

Warrensburg Country Club Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately one-half mile downstream of the dam. Within the estimated damage zone are one home, one road, and one building.

Our inspection and evaluation indicates the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass the probable maximum flood without overtopping but will pass 75 percent of the probable maximum flood, which is greater than the estimated 100-year flood. The spillway design flood recommended by the guidelines is the 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded behind the dam, the valley below the dam and the hazard zone, the spillway design flood should be 50 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were cracks on the crest of the dam, seepage downstream of the dam on the

left and right abutments, erosion on the upstream slope, a few small trees growing on both the upstream and downstream faces, and a few animal burrows on the upstream side. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

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Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WARRENSBURG COUNTRY CLUB LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Warrensburg Country Club Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary to Post Oak Creek at the Warrensburg Country Club (Plate 1). The watershed area is hilly consisting of forested area, a residential area, and a small area of the golf course at the country club (Plate 2). The dam is approximately 1,100 feet long along the crest and 30 feet high. The dam crest is 11 feet wide. The back face of the dam slopes uniformly from the crest to the valley floor below.

(2) The principal spillway from the lake is an uncontrolled 12-inch steel pipe with a canopy inlet installed in the embankment. Flow through the pipe discharges into the natural stream channel below. The emergency spillway consists of a trapezoidal cut in the natural overburden and embankment. Discharge through the emergency spillway overflows through the valley downstream to a small lake.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in Central Johnson County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an

area shown on the United States Geological Survey 7.5 minute series quadrangle map for Warrensburg West, Missouri in Section 23 of T46N, R26W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Warrensburg Country Club Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Warrensburg Country Club Lake Dam the estimated flood damage zone extends approximately one-half mile downstream of the dam. Within the estimated damage zone are one residence, a building and a road.

e. Ownership. The dam is owned by the Warrensburg Country Club, West Pine Street, P.O. Box 102, Warrensburg, Missouri, Telephone 816-747-5515.

f. Purpose of Dam. The dam forms a 12-acre lake used for recreation and as an irrigation water supply.

g. Design and Construction History. The dam was designed by the Soil Conservation Service in Warrensburg, Missouri. The construction of the dam in 1977 was done by J.C. Myers, also of Warrensburg.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled outlet pipe all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 91 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled 12-inch outlet pipe.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 1,200 cfs (Probable Maximum Flood Pool El.749.5).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 749.2 (see Plate 3)

(2) Emergency spillway crest - 747.0

(3) Principal spillway pipe invert - 744.6 (0.7 feet below design elevation due to settlement)

(4) Streambed at toe of dam - 719.0 ± (approximated from design drawings)

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,350 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 1,200 feet ± (Principal spillway pipe invert)

e. Storage (Acre-feet).

(1) Top of dam - 176

(2) Emergency spillway crest - 150

(3) Principal spillway pipe invert - 116

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 15.0

(2) Emergency spillway crest - 13.5

(3) Principal spillway pipe invert - 11.9

g. Dam.

(1) Type - Earth embankment

(2) Length - 1,100 feet

(3) Height - 30 feet ±

(4) Top width - 11 feet

(5) Side slopes - upstream face 1.0 V on 4.4 H, downstream face between 1.0 V on 2.7 H and 1.0 V on 3.2 H (see Plate 5)

(6) Zoning - Unknown.

(7) Impervious core - None.

(8) Cutoff - Core Trench.

(9) Grout curtain - None.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway.

(1) Type - 12-inch steel pipe with a canopy inlet.

(2) Inlet invert elevation - 744.6 feet m.s.l. (0.7 feet below design elevation due to settlement).

(3) Outlet invert elevation 719.7 feet m.s.l. (1.7 feet below design elevation due to settlement).

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Natural open channel to streambed.

j. Emergency Spillway.

(1) Type - Grass open channel.

(2) Width of channel - 249 feet.

(3) Emergency spillway crest - 747.0.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Natural open channel to a lake downstream of the dam.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data in the form of design drawings were made available by the Soil Conservation Service.

2.2 CONSTRUCTION

Construction records were unavailable, however, the dam was constructed in 1977.

2.3 OPERATION

Documentation of past floods was not available.

2.4 GEOLOGY

The dam is constructed across a broad shallow valley containing a minor tributary of Post Oak Creek. The soil of the dam and reservoir area consists of residual soils of the Norris-Bolivar soil association. The Norris soils are shallow (8-20 inches thick) well drained, gently sloping to steep, and developed on uplands from shale bedrock. The Bolivar soil series is moderately deep (20-40 inches thick), well drained, and developed on slopes from sandstone bedrock. For engineering purposes these soils are classified as ML, CL, SM and SC. The bedrock consists of the Cabiness subgroup of the Cherokee group of Pennsylvanian age, cyclic deposits of interbedded shale and sandstone.

2.5 EVALUATION

a. Availability. Limited engineering data were obtained from the Soil Conservation Service in the form of design drawings.

b. Adequacy. Engineering data made available were inadequate for making a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the inadequacy of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Warrensburg Country Club Lake Dam was made on 23 August 1979. The inspection team included professional engineers with experience in dam design and construction, hydrology, hydraulic engineering, and geotechnical engineering. The inspection team was accompanied by Vernon Seiler, Chairman/Lake Committee; Dan Philbrick, District Conservationist/SCS; Jerry McElhiney, Area Engineer/ SCS; Dan Messerla, Conservation Agent/Missouri Department of Conservation. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. The crest of the dam had a sparse grass cover. The upstream and downstream slopes of the embankment were covered with weeds, some grass, and a few small trees. Cracks run parallel to the centerline of the dam on both the upstream and downstream edges of the crest. The cracks are anticipated to be a result of shrinkage and consolidation. There is evidence of water from crest runoff flowing into the cracks. The cracks were found to be up to 1 inch wide and approximately 12 inches deep. Clear seepage was observed downstream of the dam at both the left and right abutments. Seepage was not observed on the downstream slope or around the principal spillway. The flow from the toe to about 15 feet below the dam crest on the left side (looking downstream) was about 2 gpm. No visible flow existed in the area of seepage on the right abutment. The seepage may or may not become a problem in the future. The only erosion observed was in silty clay (CL) material on the upstream slope. The erosion has advanced into the berm about 2 ft. and may become a problem in the future. A few animal burrows were observed on the upstream slope of the dam. The variation between the surveyed and design elevations of the principal spillway inlet and outlet indicates that settlement of the embankment has occurred. There is no evidence that the dam has ever been overtopped nor is there evidence of sliding or sinkholes. Mr. Jerry McElhiney reported that the water level has never reached the outlet. Although the embankment has minor stability problems, they are unlikely to lead to failure.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The principal spillway consists of a 12-inch steel pipe with a canopy inlet which runs through the embankment. Several feet of the pipe which were observable at each end appeared to be in good condition. The emergency spillway consisted of a trapezoidal cut in the natural overburden and

dam at the right abutment. There are no existing toe drains or relief wells.

d. Geology. The design information did not provide data on the subsurface at the dam location. According to observations by a representative of the U.S. Soil Conservation Service during construction, the foundation of the dam is reported to consist of sand, silt, and/or clay materials overlying interbedded shale, limestone, and sandstone. One outcrop of limestone, approximately 18 inches thick, was observed about ten feet below the crest of the dam on the left abutment. The limestone contained vertical joints spaced approximately four feet apart and filled with soil. Material sampled in the embankment consisted of silty clay visually classified as CL (Unified Soil Classification). The embankment also contained some shale and sandstone fragments. Seepage was observed along the contact between the embankment and the left abutment. The source of this seepage is anticipated to be from the reservoir through sandstone or limestone units in the left abutment.

e. Reservoir Area. Erosion has advanced into the berm about 2 feet at one place along the shore of the reservoir. No slides of the reservoir banks were observed.

f. Downstream Channel. The channel downstream of the spillway outlet pipe is a natural open channel to the original streambed.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control. The cracks on the crest are the most serious problem. The potential for sloughing or sliding of slope segments will increase as additional water enters the cracks. The absence of riprap on the face of the dam has resulted in wave action erosion of the embankment. If not corrected, wave action will continue to erode the embankment and could lead to slope stability problems. The growth of small trees and brush and the uncut grass is not presently a serious problem; however, if allowed to go unchecked it could cause deterioration of the embankment. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. Brush on the dam prevents inspection of the embankment and kills the smaller grasses whose roots are more effective in protecting the surface soil of the slope from erosion. The brush and tall uncut grass provides habitat for burrowing animals which can damage the embankment. The several areas of seepage which were observed should be monitored regularly for quality and quantity. Seepage can cause internal erosion creating cavities and underground channels, thereby weakening the embankment and/or abutments.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled principal spillway outlet pipe.

4.2 MAINTENANCE OF DAM

The existing maintenance program includes removal of woody vegetation as it appears on the slopes of the dam. The crest of the dam is mowed periodically, but the slopes show no evidence of mowing.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

The maintenance program should be expanded to include mowing the grass cover on the embankment in order to discourage animal burrowing. The brush and trees on the embankment should be removed more frequently. The areas of seepage should be monitored periodically and, if flows increase significantly or if seepage flows become muddy, a qualified engineer should be consulted.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics in the form of design drawings were provided by the Soil Conservation Service.

b. Experience Data. The drainage area and lake surface area are developed from USGS Warrensburg West Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The principal spillway appears to be in good condition. The lake level at the time of the inspection was below the inlet level and there was no flow through the pipe. Only the inlet and outlet ends were observable. The spillway pipe discharges with a free outfall into a natural channel. There were no obstructions to flow in the downstream channel.

(2) The emergency spillway channel is in good condition with no evidence of erosion at the time of the inspection.

(3) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway will pass 75 percent of the probable maximum flood without overtopping the dam. This flood is greater than the 100-year flood estimated to have a peak outflow of 13 cfs developed by a 24-hour, 100-year rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded by the dam and the downstream hazard, the appropriate spillway design flood should be 50 percent of the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 200 cfs of the total discharge from the reservoir of 1,400 cfs. The estimated duration of overtopping is 0.3 hours with a maximum height of 0.3 feet. The embankment should not be affected by overtopping for this short period of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately one-half mile downstream of the dam. One home, one road, and one building could be severely damaged and lives could be lost should failure of the dam occur.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Post Construction Changes. No changes have been made since completion of the dam.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone.

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are erosion of the front face of the embankment at normal lake level, cracks in the crest of the embankment, seepage from the right and left abutments, the growth of brush and trees on the embankment, and animal burrows in the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the inadequacy of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment was not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. No measures are recommended.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended:

(1) Riprap should be placed on the upstream face of the dam at the normal lake level to prevent erosion of the embankment material.

(2) The seepage areas noted during the visual inspection should be closely monitored and documented as to quantity of flow. Any significant changes should be evaluated by an engineer experienced in the design, construction, and inspection of dams.

(3) The animal burrows in the embankment should be corrected since they can lead to piping. Control measures should be implemented under the direction of a qualified engineer to discourage increased animal activity in the area. The embankment slope should be monitored during this repair.

(4) The cracking along the crest of the dam should be repaired under the direction of a qualified engineer. The embankment slope should be monitored during this repair.

(5) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed by an engineer experienced in the maintenance of earth dams. Grass cover on the embankments should be cut periodically.

(6) Seepage and stability analysis should be performed by a professional engineer experienced in the design and construction of dams.

(7) A detailed inspection of the dam should be made periodically by an engineer experienced in design and construction of dams. This inspection should include measurement of seepage flows and analyzing water samples taken from the seeps and lake. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

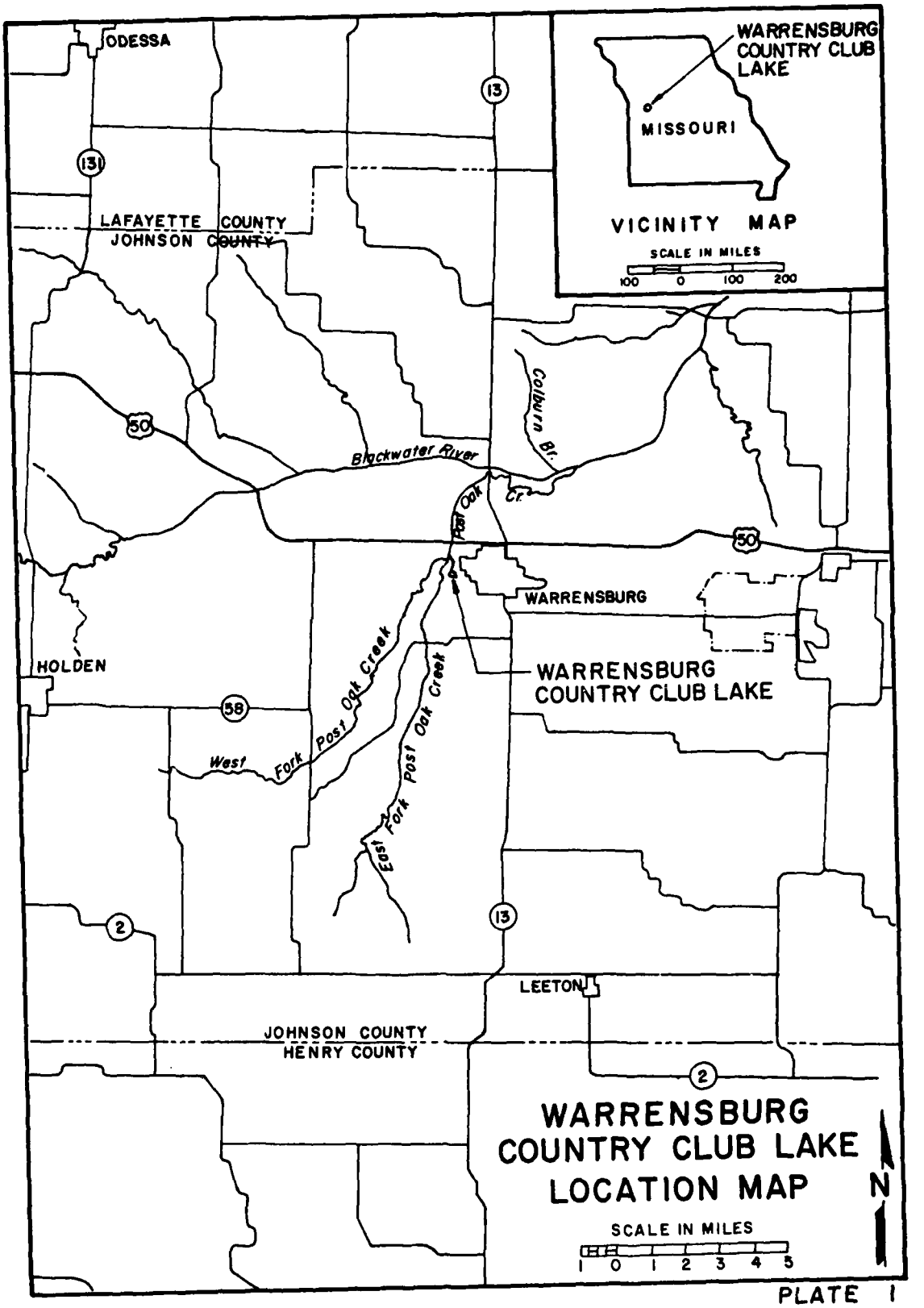
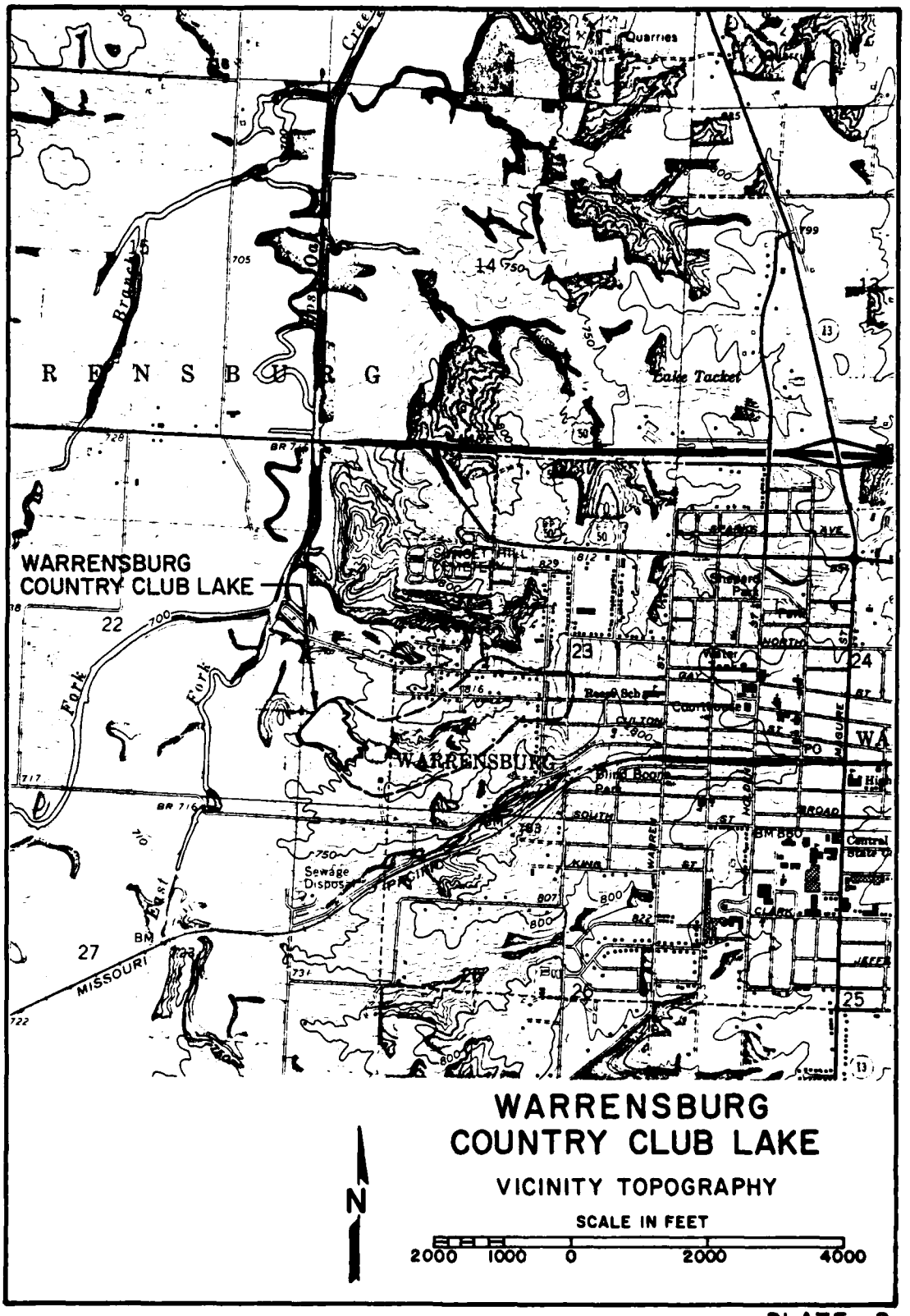

ODESSA
13
131
LAFAYETTE COUNTY
JOHNSON COUNTY
50
Blackwater River
Collurn Br.
Post Oak Cr.
50
WARRENSBURG
HOLDEN
WARRENSBURG
COUNTRY CLUB LAKE
58
West Fork Post Oak Creek
East Fork Post Oak Creek
2
13
LEETON
JOHNSON COUNTY
HENRY COUNTY
2
WARRENSBURG
COUNTRY CLUB
LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
WARRENSBURG
COUNTRY CLUB LAKE
LOCATION MAP
N
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 1



WARRENSBURG COUNTRY CLUB LAKE

VICINITY TOPOGRAPHY

SCALE IN FEET

2000 1000 0 2000 4000

PLATE 2

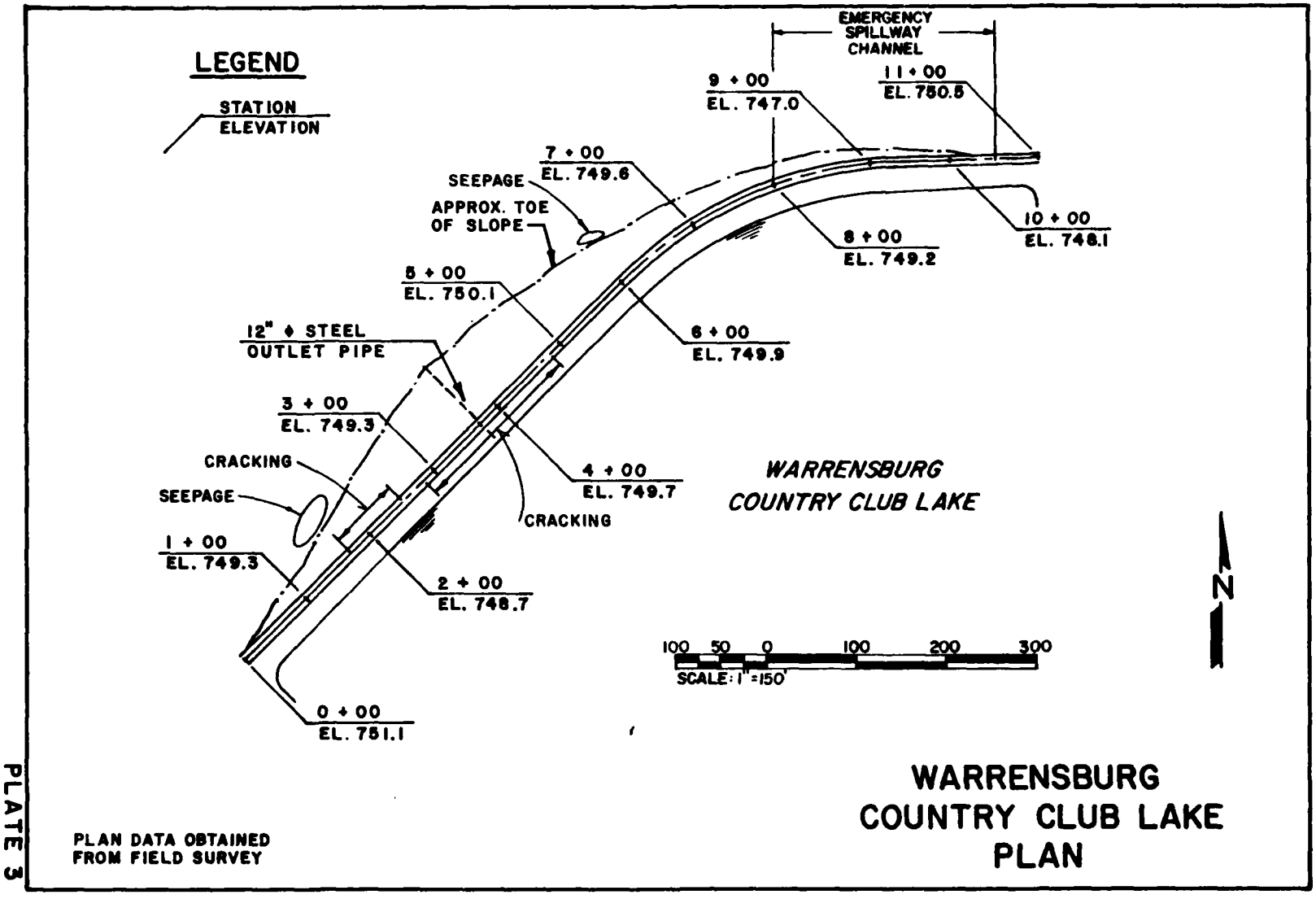
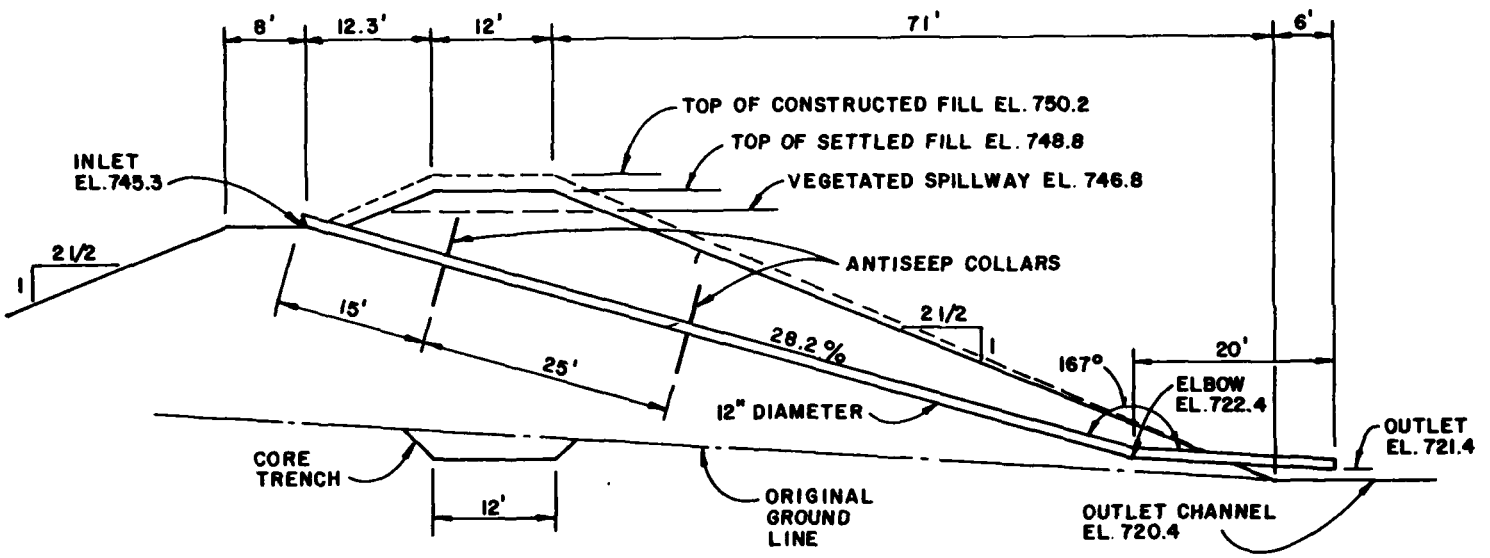

LEGEND
STATION
ELEVATION
EMERGENCY SPILLWAY CHANNEL
9 + 00
EL. 747.0
11 + 00
EL. 750.5
7 + 00
EL. 749.6
SEEPAGE
APPROX. TOE OF SLOPE
8 + 00
EL. 749.2
10 + 00
EL. 748.1
5 + 00
EL. 750.1
12" ϕ STEEL
OUTLET PIPE
6 + 00
EL. 749.9
3 + 00
EL. 749.3
CRACKING
SEEPAGE
4 + 00
EL. 749.7
CRACKING
1 + 00
EL. 749.3
2 + 00
EL. 748.7
0 + 00
EL. 751.1
WARRENSBURG
COUNTRY CLUB LAKE
N
100 50 0 100 200 300
SCALE: 1" = 150'
PLAN DATA OBTAINED FROM FIELD SURVEY
WARRENSBURG
COUNTRY CLUB LAKE
PLAN

PLATE 3



SECTION DESIGN DATA
PROVIDED BY THE SCS

WARRENSBURG COUNTRY CLUB LAKE DESIGN CROSS SECTION

PLATE 4

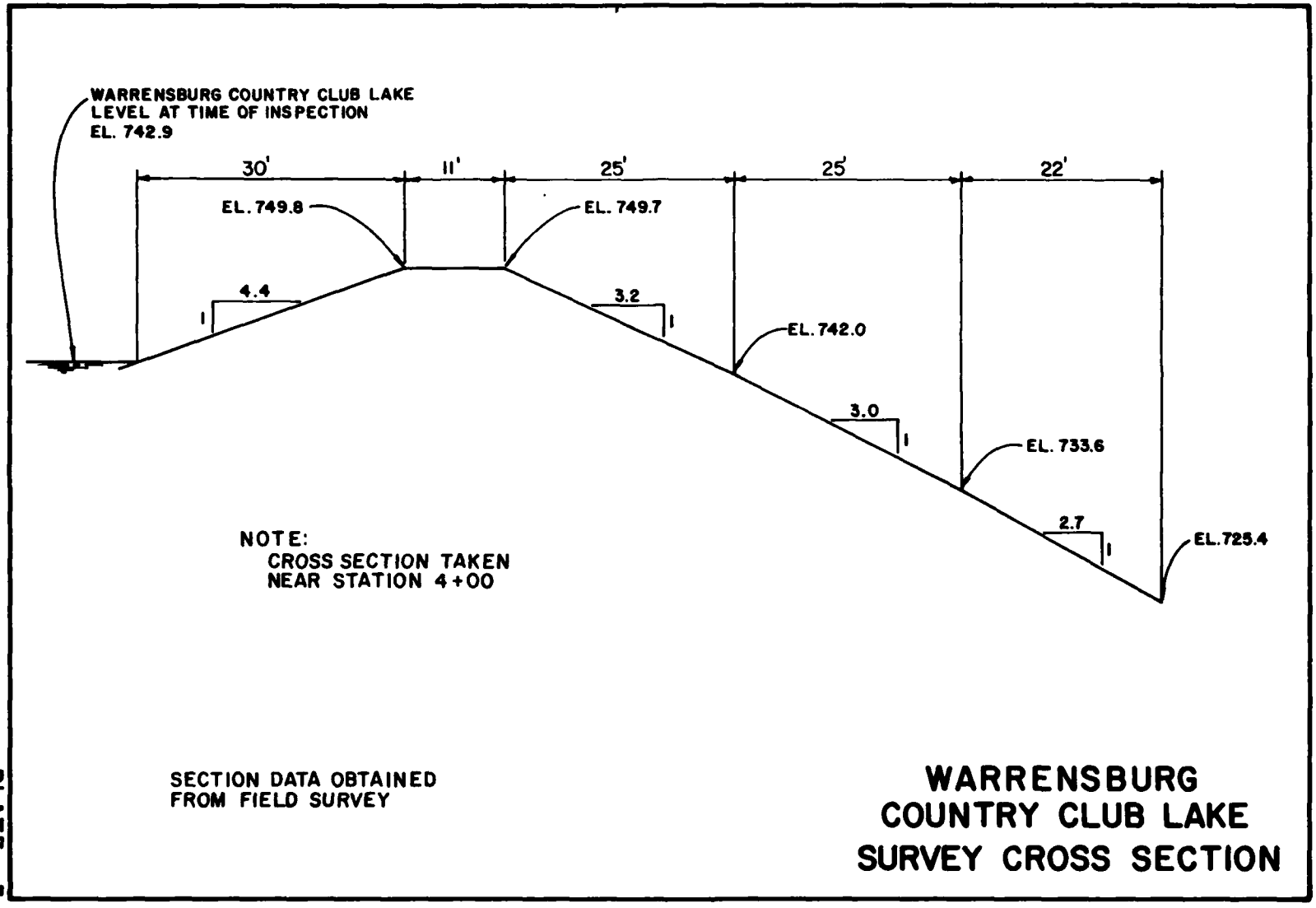


PLATE 5

WARRENSBURG COUNTRY CLUB LAKE SURVEY CROSS SECTION

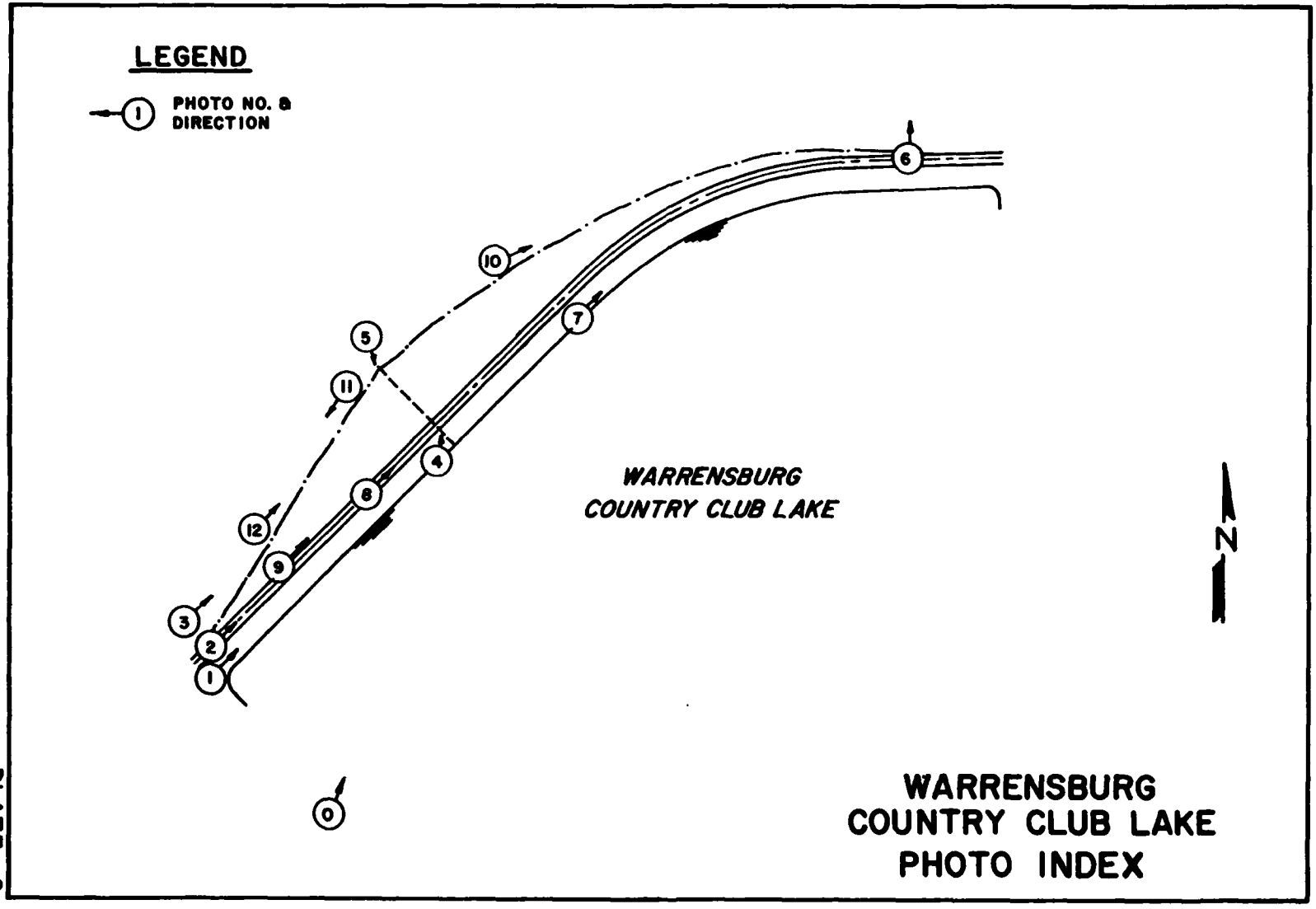

LEGEND
PHOTO NO. & DIRECTION
WARRENSBURG
COUNTRY CLUB LAKE
N
WARRENSBURG
COUNTRY CLUB LAKE
PHOTO INDEX

PLATE 6

PHOTO 1: UPSTREAM FACE OF DAM

PHOTO 2: CREST OF DAM

PHOTO 3: DOWNSTREAM FACE OF DAM

PHOTO 4: UPSTREAM END OF OUTLET PIPE

PHOTO 5: DOWNSTREAM END OF OUTLET PIPE

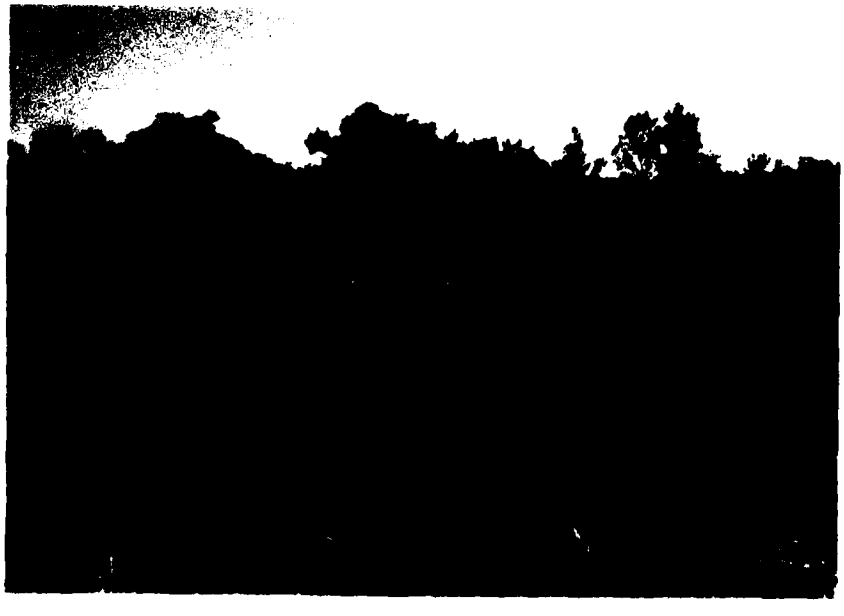


PHOTO 6: AREA BELOW EMERGENCY SPILLWAY

PHOTO 7: EROSION OF UPSTREAM FACE OF EMBANKMENT

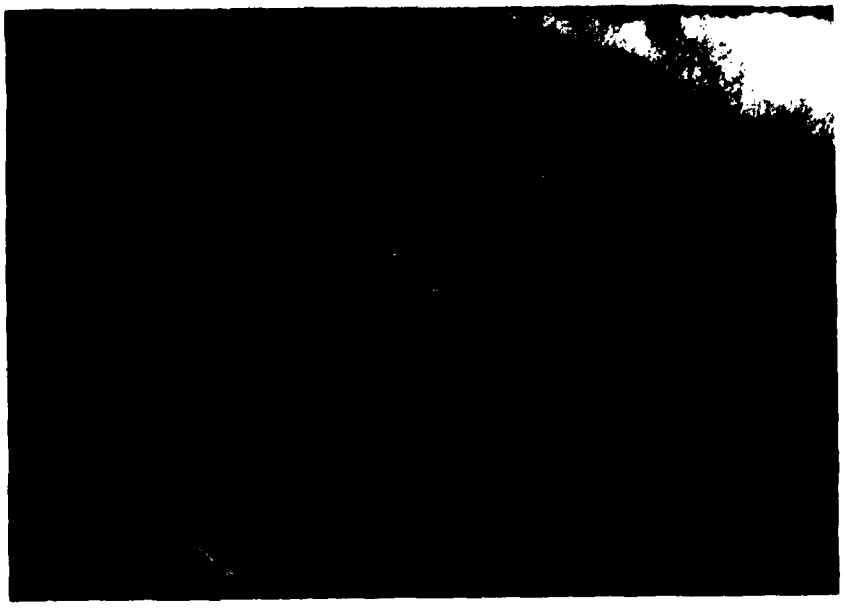


PHOTO 8: CRACKING AT UPSTREAM SIDE OF DAM CREST

PHOTO 9: CRACKING AT DOWNSTREAM SIDE OF DAM CREST

PHOTO 10: SEEPAGE AT RIGHT TOE OF DAM

PHOTO 11: SEEPAGE AT LEFT TOE OF DAM

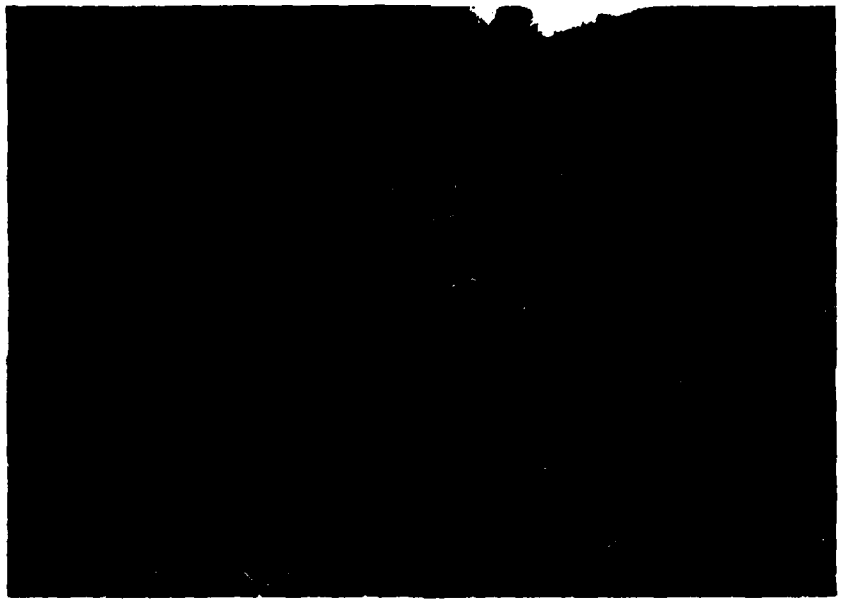


PHOTO 12: SEEPAGE AT LEFT TOE OF DAM

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrographs and hydrologic inputs as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33.

200 square mile, 24 hour rainfall inches	- 25.0
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%

b. Drainage area = 91 acres.

c. Time of concentration: $T_c = (11.9 \times L^3/H)^{0.385}$ = 0.27 hours = 16 minutes (L = 0.61 miles length of longest watercourse in miles, H = 99 feet = elevation difference in feet) (2).

d. The soil associations in this watershed are Bates, Bolivar, Norris, and Zook (3).

e. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 84 and antecedent moisture condition III (4 and 5). The hydrologic soil group in the basin was B.

2. Principal spillway release rates are based on the pressure flow through the pipe acting as an orifice.

Orifice flow equation:

$Q = Ca\,[2gH]^{1/2}$ (C = 0.51 = coefficient of discharge, a = 0.79 sq. ft. = net area of the orifice in square feet, g = gravitational acceleration, h = difference between the energy gradient elevation upstream and the tailwater elevation downstream (6).

Discharge rates for the emergency spillway and over the top of the dam are based on the weir equation for unlevel weirs:

$$Q = \frac{2Cb}{5(h_b - h_a)} (h_b^{2.5} - h_a^{2.5})$$

(C = 2.60 = weir coefficient, b = the length of flow normal to the weir in feet, h_b = the head on the low end of the weir in feet, and h_a = the head on the high end of the weir in feet.)[a](7)

3. The relationship between elevation and storage volume for the reservoir was determined from a contour map of the reservoir area. A planimeter measurement was made of the area enclosed by each contour line. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway.

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(3) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soils Report for Johnson County, Missouri.

(4) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, January, 1975.

(5) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(6) Horace W. King and Ernest F. Brater, Handbook of Hydraulics, Sixth Edition, McGraw Hill Book Company, 1976.

(7) U.S. Department of the Interior, Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter A5, Measurement of Peak Discharge at Dams by Indirect Method, by Harry Hulsing, 1967.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERS         JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
```

```
     1          A1MISSOURI DAM INSPECTION PROGRAM
     2          A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGR
     3          A3WARRENSBURG COUNTRY CLUB LAKE DAM
     4          B     288       0       5       0       0       0       0       0       0       0
     5          B1      5
     6          J       1       9       1
     7          J1     .5      .6     .65      .7     .75      .8     .85      .9      1.
     8          K       0       1                               3       1
     9          K1  WARRENSBURG COUNTRY CLUB LAKE DAM     (24 HR. PROBABLE MAXIMUM RUNOFF)
    10          M       1       2   0.143                       1
    11          P              25.0     101     120     130
    12          T                                                      -1     -84
    13          W2             0.16
    14          X                       1
    15          K       1       2                                      1
    16          K1   ROUTE THROUGH SPILLWAY
    17          Y                                       1       1
    18          Y1      1                                                  -744.6      -1
    19          Y4  744.6   745.6   746.1   747.0   747.5   748.0   748.5   749.0   749.2   749.5
    20          Y4  750.0   750.5   751.0
    21          Y5      0.     13.     13.     13.     39.    156.    400.    793.   1024.   1492.
    22          Y5 2772.   4787.   7357.
    23          $S      0.     12.     66.   184.5   372.5
    24          $E    720.    730.    740.    750.    760.
    25          $$ 744.6
    26          $D 749.2       0.     1.5      0.
    27          K      99
```

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 09/11/79.
     TIME= 11.31.14.

                    MISSOURI DAM INSPECTION PROGRAM
                    ST. LOUIS DISTRICT US ARMY CORPS OF ENGR
                    WARRENSBURG COUNTRY CLUB LAKE DAM

                                JOB SPECIFICATION
      NO      NHR     NMIN     IDAY     IHR     IMIN    METRC    IPLT    IPRT   NSTAN
     288       0        5        0       0        0        0       0       0       0
                                JOPER     NWT   LROPT   TRACE
                                    5       0       0       0

                        MULTI-PLAN ANALYSES TO BE PERFORMED
                                    NPLAN= 1  NRTIO= 9 LRTIO= 1
                RTIOS=    .50     .60     .65     .70     .75     .80     .85     .90    1.00

**********      **********      **********      **********      **********

                            SUB-AREA RUNOFF COMPUTATION

                    WARRENSBURG COUNTRY CLUB LAKE DAM    (24 HR. PROBABLE MAXIMUM RUNOFF)

                    ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE   IAUTO
                        1       0       0       0       0       3       1       0       0

                                HYDROGRAPH DATA
      IHYDG     IUHS    TAREA     SNAP    TRSDA    TRSPC    RATIO   ISNOW   ISAME   LOCAL
          1        2      .14     0.00      .14     1.00    0.000       0       0       0

                                PRECIP DATA
                    SPFE     PMS      R6     R12     R24     R48     R72     R96
                    0.00   25.00  101.00  120.00  130.00    0.00    0.00    0.00

                                LOSS DATA
     LROPT    STRKR    DLTKR    RTIOL   ERAIN   STRKS    RTIOK   STRTL   CNSTL   ALSMX   RTIMP
         0     0.00     0.00     1.00    0.00    0.00     1.00   -1.00  -84.00    0.00    0.00

                CURVE NO =  -84.00  WETNESS =   -1.00  EFFECT CN =   84.00

                                UNIT HYDROGRAPH DATA
                            TC=  0.00    LAG=   .16

                                RECESSION DATA
                        STRTQ=    0.00    QRCSN=    0.00    RTIOR= 1.00

                TIME INCREMENT TOO LARGE--(DNHQ IS GT LAG/2)

                UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=    .16  VOL= 1.00
                114.     327.     311.     175.      89.      45.      23.      12.       6.       3.
```

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	744.60	744.60	749.20
STORAGE	121.	121.	175.
OUTFLOW	0.	0.	1024.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	748.75	0.00	170.	594.	0.00	15.83	0.00
.60	748.95	0.00	172.	751.	0.00	15.83	0.00
.65	749.03	0.00	173.	832.	0.00	15.83	0.00
.70	749.11	0.00	174.	922.	0.00	15.83	0.00
.75	749.18	0.00	175.	1003.	0.00	15.83	0.00
.80	749.25	.05	176.	1096.	.08	15.83	0.00
.85	749.30	.10	176.	1185.	.25	15.83	0.00
.90	749.36	.16	177.	1268.	.25	15.83	0.00
1.00	749.46	.26	178.	1426.	.25	15.83	0.00

END

DATE
FILMED

12-81

DTIC